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CIRCULAR No. 75 JULY, 1929
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

THE TRUE CRICKET—A SERIOUS COTTON PEST IN CALIFORNIA

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INTRODUCTION

There appears to be almost no mention in economic literature of the occurrence of true crickets as a serious pest of crops. However, in his studies of cotton entomology in the Imperial Valley, crickets were the first pest encountered by the writer. Large fields were seen where crickets had completely devastated the seedling cotton or, at best, had left a 10 per cent stand. Replanting is frequently necessary. In their feeding, crickets are not confined to cotton, but devour many varieties of green foliage, tender stems, or other succulent vegetable matter.

At times of their abundance the crickets are also a pest in houses. They often get indoors, where they cause annoyance by their chirping. They congregate around sinks and garbage containers, and frequently find their way to supplies of vegetables and fruits.

A. N. Caudell, to whom the writer sent material, states:

> The species concerned is surely *Gryllus assimilis* Fabr. and is represented by more than one of the minor color forms of this species, such as variety *integer* and both long and short winged forms.

V. L. Wildermuth, of Arizona, writes as follows:

> We can say that we have never observed injury to cotton or other crops by crickets in the Salt River Valley, Arizona. I know, however, from experience just how numerous they become in the Imperial Valley. I have seen crickets carried off the sidewalks in El Centro by the bushel basket full.

It is difficult to explain the great difference in abundance in the Imperial Valley and the Arizona cotton fields, and the failure of the cricket to attain a pest status in Arizona.

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SEASONAL ACTIVITY

All the stages of the cricket pass through the winter. On February 2, 1917, a one-third-grown cricket was driven out of hiding in the ground by the application of water in irrigation. On March 26, 1917, it was noticed that crickets were becoming active in cotton fields and elsewhere. Nascent crickets were observed about fields on April 20, 1917. These records show that in the Imperial Valley true crickets become active early in the season. From field observations and laboratory tests it was established that in 1917 the hatching of overwintering eggs took place between April 20 and May 15.

Crickets are everywhere present from about April 1 until the occurrence of frosts. The greatest abundance appears to be reached during July, August, and September. As with many other insects, the demarcation between broods is not distinct, but there appear to be three fairly well-defined hatchings. The overwintering eggs give rise to a spring generation, usually about May 1. In 1917 an enormous brood of nascent nymphs appeared about July 20. The crest of a fall hatching was reached about September 20. This brood is limited in numbers, and probably the greater part of this generation normally passes the winter in the egg stage.

Hibernation in the strict sense is a doubtful phenomenon in the case of true crickets in this region. The field records show that adult crickets have been either seen or heard in every month except December. In the winter of 1917–18 the first frost occurred on the night of January 11. On the following day active crickets were recorded in a cotton field. In 1917 the earliest record of activity was on February 2. In 1919 crickets were recorded on February 13. The winters are short and mild in the Imperial Valley, and it appears established that the overwintering individuals assume merely a partially quiescent condition, accompanied, probably, by occasional limited feeding activities during warmer intervals.

NATURE OF THE DAMAGE

Injury to cotton by the attacks of crickets arises from the feeding activities upon the stem and foliage. The injury conforms usually to three types of attack. If the attacked plant is very young (1 to 3 inches high), the stem is usually severed a short distance above the ground. If the plant is from 3 to 8 inches high, the injury consists usually of gnawing and rasping the stem at some distance above the soil. If the plant is from 8 to 12 inches tall, it usually suffers only in the region of the apical bud from the gnawing or complete severance of the stem at this point. Measurements were made on 22 damaged seedling plants to determine the average location on the seedling stem of acute injury by crickets. The following figures give the height in inches above the ground of the injury: 1, 3, 3, 0, 1, 7, 1, 2½, ½, ½, 1½, 0, 1½, 0, 1½, 1, 0, 1, 0, 2, 2, 1. The average of these 22 measurements is 1.4 inches above ground, representing the point near which cricket injury is most likely to occur. Plants a foot or more high are comparatively immune from serious injury.

The pest is characteristically a night worker and becomes active

just about sundown. It is customary for the crickets to work gregariously, several individuals often congregating at the base of a stalk. On very young cotton the damage is confined to the stem. Beaver-like, these orthopterons gnaw first into one side and then another to form jagged raspings on the stalk. Except on seedling cotton, the eating activities of crickets rarely result in the entire severance of the stems, but the stems are so weakened that the plants frequently die and snap off at the point of attack.

Large fields are often so completely damaged by crickets as to make replanting necessary. It is not unusual for planters to be compelled to replant twice, and even then a good stand is not always obtained.

Crickets appear to be fond of alfalfa, which commonly grows as a volunteer around fields. Often a dense border of alfalfa occurs adjacent to cotton, and such a border frequently serves as headquarters for crickets advancing on cotton.

DAMAGE WORST AFTER A GRAIN CROP

It is an established fact that severe injury by the true crickets is more likely to occur on cotton following a winter crop of grain, especially barley. There are several reasons for this. (1) The soil in these fields is not disturbed until so late that wintering crickets emerge from the ground without hindrance. (2) These fields while in barley become entirely covered with surface cracks, so characteristic of the Imperial Valley silts, thus affording abundant hiding places which are vital in the cricket economy. (3) The preparation of the land for cotton drives many of the individuals to the borders, where they await an opportunity to reinvade the fields upon the appearance of the cotton. (4) Cotton planted after barley is so late that it is very attractive to crickets at just the time when they occur abundantly.

OCCURRENCE IN OLDER FIELDS

Crickets are to be found in cotton fields throughout the growing season. On July 25, 1917, myriads of nascent crickets were observed in several fields of waist-high cotton. These were just under the soil surface of the ridges in the daytime, and hardly a plant was free from the feeding lesions of this recent brood. Most of the feeding was confined to the lower foliage. An occasional gnawed square or boll was seen, but aside from this little damage results to cotton of that height.

In a preliminary report on the cotton insects of the Imperial Valley, W. Dwight Pierce stated: "One or two crickets were found feeding upon the cotton blossoms. This species has been determined as *Miogryllus pictus* Scudder, by A. N. Caudell."

On August 15, 1917, a cotton field was examined while irrigation was in progress. As the flow advanced down the furrows the crickets scurried out of crevices just ahead of the approaching water. On the basis of counts made for given distances along several furrows it was estimated that in this field there were about 20,000 crickets per acre. This would be at the rate of between 3 and 4 crickets per plant.

EGG LAYING

The details relating to oviposition by the true crickets have been rather carefully worked out. For these biological studies a soil table was constructed as follows: The top or bed of the table was surrounded by a ledge of 6-inch strips, thus permitting a soil depth of about 5 inches. Drainage was provided for. Cotton was planted over portions of the seed bed and soon germinated. Lamp chimneys were imbedded in the soil and were covered at the top with cheesecloth, to serve as rearing cells.

On April 24, 1917, a cell was placed over a tender cotton seedling, and an adult female cricket was introduced at 9 a. m. By 2 p. m. the seedling had been completely girdled and one of the characteristic ovipositing pits had been dug. The nature of these holes is quite constant. They are obconical in shape and about large enough to receive one's finger to the first joint. In digging the hole the cricket works head down, throwing out soil particles with her fore and middle legs, much after the manner of a dog when pawing in the ground. When a lump is encountered too large to be removed by the scratching process, the female grabs it with the forelegs and backs out, dragging it to the top of the burrow. Excavation continues until only the tip of the abdomen projects above the hole.

When the pit has been sunk to this depth the female deftly reverses her position so that the tip of the abdomen is directed downward at the bottom of the pit. The tips of the wing covers and the paired abdominal appendages serve as a tripod, enabling the female to manipulate the ovipositor to the best advantage. By a series of pushing movements with the four anterior legs, by pulling with the hind legs which are kept deep in the hole, and by using the body weight to the best advantage, the ovipositor is thrust well down into the soft soil beneath the base of the hole. At this time the female works excitedly with all six legs in an apparent effort to force the terminal organ to its greatest possible depth. When clear down, the cricket remains quiet about a minute, during which the operations incident to the extrusion of the egg are completed. At this time the paired appendages are bent at right angles, permitting the tip of the abdomen to strike the soil surface. This bending of the caudal appendages probably serves to facilitate the passage of the ovum. Then, by gradually tensing the legs, the female slowly lifts the body and ovipositor until the latter is all but free from the tiny bore in the soil through which it has just been forced. Next she slowly thrusts it down again, probably swerving slightly out of the old passage, so that each egg finally rests by the side of another, rather than being superimposed on another. Usually about a minute elapses between ovipositional insertions. After about 10 minutes of egg laying the female, as a rule, desists long enough to feed on near-by vegetation. Resuming operations, the female at first works head down in the pit, using the mouth parts for some purpose not ascertained. Soon she whirls around, skillfully dropping the ovipositor into place at the apex of the pit. The above program is often repeated, and when the full quota of eggs has been deposited the pit is carefully filled with soil. This filling is nicely done so that the soil surface gives no evidence of having been disturbed.

From the foregoing discussion of oviposition under control, it is seen that the principal requirement for egg laying is access to soft, moist soil. Owing to the network of canals and ditches which covers the entire Imperial Valley, there is no lack of favorable positions for egg laying. In addition, innumerable eggs are deposited along the furrows in the cotton fields.

HYDROTROPISM

It has often been observed during the oviposition period that if water is applied so as to moisten the soil under the rearing cell, the egg-laying activities of the female cricket receive a stimulus. Excavating is engaged in with feverish activity, but the digging operations are soon interrupted through the strong desire, in the presence of moisture, to oviposit. At these times the female eagerly thrusts the ovipositor down to its limit. Then she returns to the pit and resumes excavating.

THE EGG

Where eggs are deposited normally—that is, at the base of the excavated pit—the average depth below the soil surface appears to be about 1¼ inches, but where they are inserted from the ground level the eggs are placed only about one-half inch deep. The eggs are laid one at a time in a vertical position and are not glued together as are the eggs of many other orthopterons.

A peculiar fact about eggs of the cricket *Gryllus assimilis* is the property they possess of "snapping" so as to change their position. This phenomenon has been observed when normally deposited eggs have been disturbed. It is not known wherein lies the power of accomplishing this "snapping." The most natural assumption would be that these eggs contained parasites, and it must be admitted that this possibility was not eliminated. However, all such "snapping" eggs observed appeared quite normal externally, and the chances are against their having been parasitized.

The cricket egg is banana-shaped, with very little curve to its axis. The two ends are very similar, and no reticulations or sculpturings are to be seen. The freshly deposited egg is straw colored or pale amber. The measurements of a series of seven eggs are given in Table 1.

TABLE 1.—*Measurements of eggs of the true cricket, Gryllus assimilis*

Egg No.	Length	Thickness	Egg No.	Length	Thickness
	Mm.	*Mm.*		*Mm.*	*Mm.*
1	2.94	0.72	6	2.25	0.48
2	2.64	.66	7	2.22	.48
3	2.70	.69			
4	2.22	.51	Average	2.47	.57
5	2.31	.48			

The total number of eggs deposited by a female in the course of her lifetime is unknown. It is likely that a given female will commonly deposit more than one egg mass. In the case of the crickets in the

laboratory experiments the egg clusters varied considerably in size, but it would appear that under favorable conditions the average progeny per egg mass is about 75.

INCUBATION

The available data on the egg period are presented in Table 2.

TABLE 2.—*Incubation of eggs of the true cricket, Gryllus assimilis*

Batch	Eggs deposited	Eggs hatched	Incubation period
1	Aug. 24	Sept. 2	9 days.
2	Aug. 28	Sept. 5–7	8 to 10 days.
3	Aug. 28	Sept. 5 and 10	8 and 13 days.
4	Sept. 6	Sept. 20	14 days.

Average incubation period, 10.6 days.

From the data at hand it will be seen that the incubation period ranges from 8 to 14 days. This is for late August and early September, at which time midsummer conditions prevail in the Imperial Valley. On a few occasions the writer has also tried to carry eggs through the winter, but these failed to hatch, partly because of mortality from freezing and other environmental causes.

THE NASCENT NYMPH

The newly hatched cricket is characterized by a blackish head, whitish thorax, and pale chestnut-colored abdomen. Prior to feeding, nascent nymphs have a pale bleached color, but after a few hours this darkens. A series of newly hatched unfed crickets yielded the following average measurements: Length (head to abdomen, inclusive), 2.46 millimeters; width (across abdomen), 0.63 millimeter.

In the laboratory experiments nymphs have been kept as long as seven weeks in cells with ample food. During this time they developed much and approached maturity, although none reached the adult stage. The writer never observed an indvidual in the act of molting nor has he been able to find any trace of the shed skins. The omnivorous habits of crickets are well known, and it is quite possible that in confinement they may devour their own exuviae. Observations were made every 24 hours.

BROODS

Field data and observations in the laboratory seem to indicate that the first brood (from overwintered eggs) requires about 11 weeks and the second brood about 8 weeks for development. There is a partial fall brood in the Imperial Valley, but it is quite certain that most of the eggs of this generation pass through the winter in the ground.

PHOTOTROPISM

It is a very common occurrence in midsummer and early fall to observe crickets congregated in great numbers around and under street lights. Also, in most instances where lights have been used

in tests for phototropism in the Imperial Valley, crickets have been attracted in the greatest proportion of all the species observed. They respond markedly to the stimulus of light. On the other hand, they do not feed by daylight but seek shelter in the ground during the day.

NATURAL ENEMIES

Crickets seem to be comparatively free from insect enemies. A large red mite (a species of Euthrombidium) is probably the only important parasite with which they have to contend. Many crickets are seen in the field so weakened through the attack of this mite that they are barely able to move about. These mites attach themselves mostly under the wings and are often imbricated in large numbers on their host's dorsal surface.

Regarding the destruction of crickets of the species *Gryllus assimilis*, the Bureau of Biological Survey has furnished the following data from its files:

> Reference to our files of bird stomach examination reveals the fact that we have recorded *Gryllus assimilis* in the food of the following species of birds: Pipit (*Anthus rubescens*), broad-winged hawk (*Buteo platypterus*), pigeon hawk (*Falco columbarius*), loggerhead shrike (*Lanius ludovicianus*), ring-billed gull (*Larus delawarensis*), black-bellied plover (*Squatarola squatarola*), and curve-billed thrasher (*Toxostoma curvirostre*). Specimens referable to the genus Gryllus have been found in the stomachs of no less than 68 different species of birds. That crickets as a group form an important part of the food of birds is reflected by the fact that fragments referable to the family Gryllidae were found in the stomachs of approximately 200 species of birds.

Owing to the insect's nocturnal habits it is possible that many individuals may be killed by the small desert owl (*Speotyto cunicularia hypogaea*) which is extremely abundant in the Imperial Valley. In Farmers' Bulletin 1102[1] of the United States Department of Agriculture it is stated that crickets form a part of the diet of the common crow (*Corvus brachyrhynchos*).

CONTROL

Since the severest cases of cricket damage occur in fields of cotton following barley and other small grains, it is clear that this sequence should be avoided as far as possible. Even if one were to ignore the possible loss from crickets, it is poor farming practice to follow winter grain with cotton. The latter is a long-season crop, and the ground for it should be broken in January; this is not possible following grain.

Since crickets require crevices for hiding during daytime, it follows that this requirement can be thwarted by careful cultivation. The cultivation will directly kill a certain percentage of the crickets present in the field, and if the surface soil is reduced to a fine mulch it will be difficult for the pest to maintain itself. Also the borders in and around cotton fields should be kept as free from weed growth as possible so as to eliminate congregating shelters.

Owing to the fact that crickets are attracted strongly to lights, it would seem that great numbers could be trapped by placing attracting lights around cotton fields. In a preliminary test, ordinary lanterns

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[1] KALMBACH, E. R. THE CROW IN ITS RELATION TO AGRICULTURE. U. S. Dept. Agr. Farmers' Bul. 1102, 20 p., illus. 1920.

were placed over wide shallow pans containing water and a surface film of kerosene. Great numbers of crickets were attracted and destroyed. Strong electric lights naturally would be more effective.

Poisoned baits were not tested as a means of cricket control. From a knowledge of their feeding habits there can be no doubt that these insects would yield readily to such treatment. In fact, crickets should be more easily controlled by poison bait than are grasshoppers, for two reasons. (1) Since they relish every conceivable kind of filth of a vegetable nature, it would be easy to provide a medium for the poison. (2) Since they are nocturnal feeders, less care would be required to keep the bait moist during the feeding period than in the case of grasshoppers, which feed in the heat of the day. By the cautious use of poisoned garbage, crickets living indoors no doubt can be readily exterminated.

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